

## Article

# Living Heritage in the Urban Landscape. Case Study of the Budapest World Heritage Site Andrassy Avenue

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**Abstract:** Historic allées and urban avenues reflect a far-sighted and forward-thinking design attitude. These compositions are the living witnesses of olden times, suggesting permanence. However, the 20th century's urban development severely damaged the environment, therefore hundred-year-old mature trees are relatively rare among city avenues' stands. Due to the deteriorated habitat conditions, replantation may be necessary from time to time. However, there are a large number of replanted allées and urban avenues considered historical monuments, according to the relevant international literature in urban and living heritage's preservation. The renewal often results in planting a different, urban tolerant taxon, as seen in several examples reviewed. Nevertheless, the allée remains an essential urban structural element, though often with a changed character. The Budapest Andrassy Avenue, a city and nature connection defined in the late 19th century's urban landscape planning, aimed to offer a splendid link between city core and nature in Városliget Public Park. The 19–20th century's history and urban development are well documented in Hungarian and several English publications, though current tree stock stand and linear urban green infrastructure as part of the urban landscape need a detailed survey. The site analyses ran in 2020–early 2021 created a basis for assessing the allées and the whole avenue as an urban ecosystem and a valuable case study of contemporary heritage protection problems. Andrassy Avenue, the unique urban fabric, architecture, and promenades have been a world heritage monument of cultural value since 2002. The allées became endangered despite reconstruction type maintenance efforts. The presented survey analyses the living heritage's former renewal programs and underlines the necessity of new reconstruction concepts in urban heritage protection. We hypothesize that urban green infrastructure development, the main issue in the 21<sup>st</sup> century to improve the urban ecological system and human liveability, may support heritage protection. The Budapest World Heritage Site is worthwhile for a complex renewal where the urban green ecosystem supply and liveable, pedestrian-friendly urban open space system are at the forefront to recall the once glorious, socially and aesthetically attractive avenue.

**Keywords:** allées; urban avenues; World Heritage Site; urban habitat; urban ecosystem supply; renewal method



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## 1. Introduction

Complete allée renewals occur in city avenues. Due to the ecological alteration of the urban habitat and the deterioration of its quality, it is often impossible to keep the mature trees and even the original tree species in the necessary renewal process. From the many examples, we highlight Andrassy Avenue's birth [1] and renewal in Budapest. A 19th-century development went on a staged, total renewal with the tree species' substitution in several phases during the 20th-century. Currently the avenue offers a different streetscape

in each segment (regarding the taxon, the age and quality), somewhat adapting to the changing urban habitat conditions. However, the original compositional intention of urban open space design is now the only history, as the avenue's image has radically changed. A new approach would be needed to preserve the listed world heritage's living components and strengthen the urban green infrastructure element's ecosystem supply.

### *1.1. Urban Allées—from Garden Art to Urban Landscape Architecture—A Literature Review*

According to the origin of urban allées, we have to distinguish the formal, functional and social aspects. The allée was a traditional garden art element in the late Renaissance. Then, allées in Baroque gardens and hunting parks stepped out into the open landscape with representation and directing functions. However, in private ownership gardens, they supplied only the privileged.

The London Hyde Park, originally a sizeable royal hunting park, was the first offered for restricted public use in 1637 [2]. The Berlin Tiergarten opened its gates for the public in 1659. The Austrian Empress, Maria Theresa, also allowed regular public use for Vienna's residents in the Prater (1766), the Augarten (1775) and the Belvedere (1776). These parks, or hunting fields, had a large-scaled garden character using perspective design and traditional garden elements like ponds and lakes, large meadows, roads, paths and architectural features [3]. They created the canopy by woods, clumps, and allées, even in the landscape garden period from the early 18th century. The Cracow Planty garden, built on the site of old town walls and towers in the early 19th century, is an excellent example of a residential activity that gave birth to a ring-form allée and garden system [4].

Trees and allées planned and planted in Paris in 1616 for a mere recreational carriage riding, served Marie de' Medici's pleasures. The allée run along the Seine beyond the Tuileries garden walls [5]. Later in the 17th century, tree allées "in the urban landscape were largely public spaces, to be enjoyed by many people, if not by all classes of society" [6]. A more than 1 km-long Unter den Linden in Berlin was planted with 2000 nut and linden trees in 1647. It ran from the city core to the open landscape, the hunting park, the Tiergarten, later a public park for the citizens of Berlin. In the 18th century, the city grew around the linden tree avenue. Hamburg had a similar double tree-lined avenue called the Jungfernstied in this period and later, in the 19th century, the famous Palmallee in Hamburg-Altona. Together with the Munich Maximilianstrasse, the Berlin Kurfürsterdamm, and the Düsseldorf Königsallee, these large-scaled green linear public open spaces perished during the World War II bombings. The avenues' reconstruction or renewal started only from the late 1950s and early 1960s, when tree nurseries' production could supply the cities with sufficient, good-quality saplings [7].

Urban expansion and the growing economic differences of the urban population in the 18th century led to severe tension in the society, among others, in environment quality and access to urban public open spaces. Along with the Enlightenment's philosophy, new ideas and principles for urban development formed the Embellishment movement. With four aims: order, hygiene, light, and cultural, aesthetic requirements, urban development could help solve social and urban environment problems. Urban embellishment utilised some large-scaled Baroque principles, the so-called French-style's garden design elements, as vues and allées. By the end of the century, with the superb French and British examples, most European towns created promenades, urban allées for public use [6].

The Paris Champs-Élysées might be one of the exemplary promenades and the Baroque garden style's living evidence of the origin of urban allées. It was André Le Notre, the royal garden designer of Louis XIV., who laid out the Tuileries Garden extension in 1667. The wide promenade with two rows of elm trees run from the royal palace to the Rond Point. When new sections were added, first in 1710 to the Place d'Étoile, then in 1765 to the Porte, the Le Notre style still ruled the design [8]. Since then, the Champs-Élysées, with its two double rows of trees and 70-m width, could accommodate both the urban traffic and the promenade function. However, the past decades' heavy urban car traffic seriously damaged both the environmental quality and social acceptance. According to

Paris chief major's statement, an exemplary renewal may come in the short future. Anne Hidalgo told the *Le Journal du Dimanche* on January 10, 2021, that she envisioned an extensional urban open space, a so-called linear garden where car traffic would be halved to give pedestrians space, intensive greening and liveable urban open space.

Besides Paris and the Champs-Élysées, we may refer to many other European examples, but search for previews to the Andrassy Avenue development in the Hungarian capital, Vienna, and even the German-speaking countries undoubtedly offer suitable models for urban allées. Until the mid-19th century, the Austrian capital offered urban recreation only in the suburban green areas and allées, for example, the Prater with its large-scaled main allée. Vienna maintained the town wall system and the old town centre's glacis where building was strictly prohibited. The glacis, crisscrossed by various allées linking the old town and the suburbs, gave place to the new Ringstrasse only after the wall demolition in the 1850s. As a result of a planning competition, the new, tree-lined boulevard served the necessary transport and traffic needs, besides organised urban squares, public gardens, parks, and cultural institutions, such as theatres, museums, and government buildings [6].

Owing to the industrial and economic development during the twentieth century, the world witnessed the rise of many metropolises representing the centre of political power and residential compaction. However, the mass urbanisation and the dense population have negatively impacted the cities' historic cores and urban environment. Due to the significant changes in the daily activities and needs of the citizens, it is unlikely for a traditional city to retain its original character; hence, the concept of urban conservation aimed to preserve historical cities as recognised heritage and help to maintain the sense of continuity and tradition [9].

In addition to the international urban conservation guidelines, regional and national regulations are mandatory to consider the treated region's local specificities, as a case in point, the example of the Five Avenues District in Tianjin, China. The region's British occupation profoundly impacted the district's development, resulting in numerous high-quality residential areas for the British concession, foreigners, and Chinese celebrities. On the other hand, a new neighbourhood borne with the development in the 1930s. However, the Five Avenues District's original function has changed throughout time to become a more mixed-use district. Nevertheless, the district has shown the capacity to meet the contemporary demands and save its authenticity owing to local conservation strategies. The scientifically based conservation plan launched by stakeholders aimed to preserve the urban and regional heritage by preventing high-rise buildings from the perspective view. Moreover, the plan aimed to buildings' categorisation based on historical values and requirements and applied a technical renovation for each category with strict control for non-historic buildings' facades. Lastly, stakeholders invited the community to the conservation procedure by creating online surveys and collecting data about citizens' contemporary demands. The municipality's new implementations align with the historic urban landscape paradigm and promote society's development [10].

### 1.2. Andrassy Avenue and Its Importance in the Urban Landscape

The story of Andrassy Avenue can be traced back to the times after the Austro-Hungarian Compromise of 1867. The establishment of an avenue connecting the city centre and the City Park (Városliget) was an essential element in Prime Minister Gyula Andrássy's urban development programme [1]. The avenue got its name after him in 1883, to be later renamed Stalin Avenue in 1950, Avenue of Hungarian Youth in 1956, Avenue of People's Republic in 1957 and finally, in 1990, the original and authentic name of Count Andrassy [11]. The long list of street names and political stress to rewrite the city-text reflects a Hungary tradition, similarly to several Central and Eastern European countries, although here in Budapest, the Andrassy Avenue has left the public memory [12].

As aforementioned, the renaming of important streets usually derived from cultural politics, especially in post-socialist eras. The cities played an essential role in socialist regimes [13], where the symbolic control of urban centres belonged to the socialist sys-

tem [14]. Therefore, this can be interpreted as a reconfiguration of both the places and their history. An example of such is the Bulevardul Carol I, located in Bucharest and named after Romania's first king, which later became Bulevardul Republicii (Boulevard of the Republic) in the way of de-commemoration of the previous regime and commemorating the socialist era. After the revolution of 1989, the original name of the boulevard was reinstated [15]. Within a more contemporary scenario, the Romanian Timisoara city renamed several streets after martyrs, mainly in the 1990s and after 2010. This political approach proved to be not so welcomed by the population due to cultural and historical aspects and the economic and practical ones as well [13]. Another example is Capital Street (Ulica Stoleczna) in Poland. This artery was planned in 1919 to connect the first housing development of the Warsaw Housing Cooperative to the city centre. In 1934, it was renamed as Popiechiszko Street, after the chaplain Jerzy Popieluszko. Even though he was cherished by the community and played an essential role during the Solidarity movement, this decision was contested by some part of the populations, claiming that Capital Street had too great historical value to be renamed [16].

Moving back to the Hungarian scenario, the plan of the great Andrásy Avenue had been elaborated by 1876. The promenade is divided into three segments, with a broader space in each part, offering a pleasant and elegant open space suited equally for carriage, horse rides and walks [17] (Figure 1). The greenway consisted of double-tree lines in its first segment running from the city centre. Further, in the second and third sections running through the outskirts, the plantation formed  $2 \times 2$  lines in the even broader cross-sections. This exquisite design symbolised the experience of arriving from Town to Nature; the latter represented by the first urban public park, the City Park of Budapest, designed by H. Nebbien in classical landscape garden style. The approximately 2km-long avenue offered the green corridor of almost 600 plane trees (*Platanus × hybrida*), the same species used in the Városliget's allées and clumps [18,19].

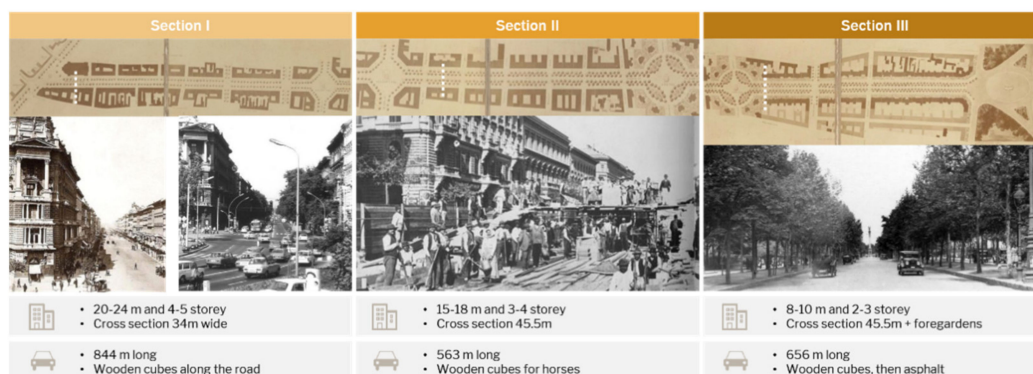


Figure 1. Map of the inner Pest region with the three sections. (edited by Rosa & Lahmar).

During the preliminaries to the millennium exhibitions and ceremonies of 1896, the first continental underground was built along Andrásy Avenue, emphasising the protection of the well-established twenty-year-old plane trees with lovely canopies at that time. Owing to the careful planning and execution, only 23 trees needed to be felled,



primarily because of the stations' construction. Thanks to the Public Works Council's commitment and the City Park's entire community, the avenue's reconstruction reflected an ideal investment approach in terms of environmental ethics aspects (Figure 2).



**Figure 2.** Character and cross-sections along Andrassy Avenue (19th–mid 20th century). (edited by Rosa & Lahmar).

However, the plane tree avenue as an urban habitat suffered its first damage due to the underground's structure that strongly inhibited the roots' spread. Building debris and stone caused severe deterioration in the natural soil system. Instead of the original wooden cube cover, the new cobblestone cover resulted in a decreased soil's ventilation.

The First World War caused severe destruction in Andrassy Avenue since, because of the overall coal shortage, people used the trees as firewood. As a result, in 1920, the whole avenue was replanted. This time, as if correcting the earlier mistake, the nettle tree (*Celtis occidentalis*) was used in the inner part where the living space is tighter and more shaded, thus not convenient for *Platanus* trees. The deterioration of the allée's habitat and quality accelerated in the 1930s when the block-pavement was replaced by asphalt. Because of the growing vehicle traffic and consequent road salting in winter, by the 1960s, the plane trees' decline became visible. Degraded trees cannot withstand the attack of bacteria, fungi and animal pests known in the literature as "weakness" pests; the Andrassy's plane trees suffered from the spread of *Apiognomonina veneta* disease. The spacious crown shape has overgrown the boulevard space over time. The dark foliage tunnel, however, in calm weather, might have reduced the vertical mixing and transmission of vehicle's pollutants, which led to a further problem because of the ever-increasing traffic [19].

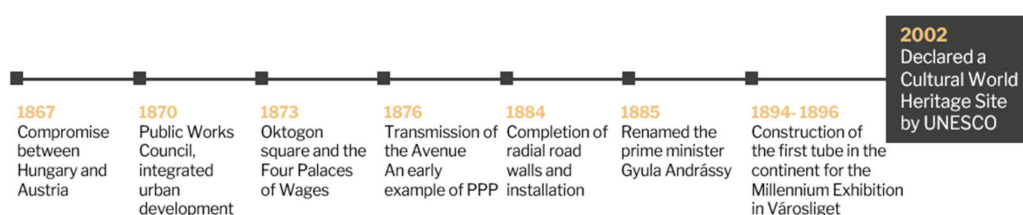
Despite the deteriorating health of the trees, the avenue still showed an almost enclosed vaulted structure. According to Mihály Mőcsényi's professional opinion, the plane trees should have been rejuvenated in the early 1970s at the latest, when the signs of deterioration were clear. The tree's disease and destruction is the symptom of the complex "urban damage". Modern urban landscape planning principles and high quality technical and reconstruction methods may reduce the disadvantages [20].

Unfortunately, nothing happened to improve the urban habitat along Andrassy Avenue. The tree survey in 1987 recorded merely 36 healthy plane trees. The repair and preservation of the plane tree avenue became more and more desperate. In 1996 and finally, in 2005, a total renewal went on using ash trees (*Fraxinus excelsior*) in the middle and columnar ash trees (*Fraxinus excelsior* 'Westhof's Glorie') in the third section [19]. For a decade, the ash tree avenue showed promising growth. Still, the once supposed urban tolerant taxa seem to start suffering from the traffic burden and a new ash tree disease. In contrast, the columnar habit of ash trees presents an entirely different view from the original stand.

The total avenue renewal might be inevitable since there was no chance and no will to reduce traffic intensity. However, the magnificent, almost closed green vault disappeared with the plane trees, which was characteristic in the middle and outer part of the Andrassy Avenue and evoked 19th-century garden art. The new plantation character, the narrow

conical canopy shape and the weaker branch system, and the smaller foliage are not ideal for the avenue's scale. The new plantation along the allée offers a far-too urban image with the canopy branching grown on a high stem (around 3.50 m). The result of the total renewal is a certainly lasting avenue ensemble that requires less tree maintenance but unfortunately distorts Andrassy Avenue's design philosophy, its character, and aesthetic value.

In 2002 the Andrassy Avenue with the buffer zone in the 6th-district, the Heroes square, and Városliget urban park in the 14th-district won World Heritage Site's honorary title as cultural heritage (Figure 3). Unfortunately, owing to excessive urban development in the protected zone, the UNESCO World Heritage Centre raised severe objections. It warned the Hungarian government that the Budapest site could be declared endangered [21]. The related Decision 43 COM 7B.84 of WHC/19/43.COM/18 severely criticised the potential impacts of extensive developments within the Városliget area and the Buda Castle Quarter. It noted, with regret, the state of property conservation and the overall approach to conservation and development. Unfortunately, the phenomenon is similar to post-socialist cities' actions that followed a path of economic growth and the idea of neoliberal competition in a regional context. Urban policy and development served city branding and the dynamism of economic growth in the end [22]. As a result, conservation considerations were relegated to the background. It can be seen in the properties' renewal of valuable public and private buildings in the listed areas and zones as along Andrassy Avenue.



**Figure 3.** Andrassy Avenue development—Timeline. (edited by Rosa & Lahmar).

Along with our hypothesis that the contemporary European issue of urban green infrastructure should be a vital issue in heritage protection, we highlight the moments when the urban avenue's allées played a determining role in the construction and renewal process. In this way, the urban landscape aspect would call attention to the central issue in the 21st century's urban liveability and ecological matters. On the other hand, we will add new elements to the academic debate on the renewal possibilities and ways. Besides elementary urban ecological aspects, the social context and the visual-aesthetical embellishment are essential in planning and decision making. The debate about urban tolerant taxon and the diversity in planting design raises questions in landscape architectural harmony and sustainability aspects.

## 2. Materials and Methods

Andrassy Avenue's research reflects the general scientific method used in landscape architecture topics. First, the literature survey helped the historical introduction of urban allées and Andrassy Avenue development. Then, we run a detailed site analysis to understand the avenue's character, role and values in the urban structural–functional and ecosystem supply contexts. As for the greenery, the tree stock investigation consisted of dendrological and dendrometrical visual analyses in the same period of the year.

### 2.1. Site Survey of the Urban Avenue as a Linear Green Open Space

A site survey of the urban landscape went on in the autumn and winter of 2020–2021 to analyse Andrassy Avenue as an urban linear green space, part of the Budapest World Heritage site. This part of the research focuses on the urban landscape, the architectural values, the urban habitat, the environmental problems, public-use forms and intensity, and urban character. As aforementioned in this paper, Andrassy Avenue has three different

sections with typical cross-sections and urban landscape characters; these sections create the logic of site analyses and evaluation. This part of the research focuses on Andrassy Avenue's development documented in urban planning maps and publications. During the site survey, we detected the public-use forms and the intensity. We examined the urban landscape's character in each section and subsection on trees' quality and uniformity, and urban habitat.

## 2.2. Dendrological and Dendrometrical Survey

The trees are the "aristocrats of the plant kingdom" [23], and in an urban setting, a specimen with a beautiful, healthy conspicuous crown can be a prominent element. Trees in the urban environment have a unique value [24], and with proper preservation, their outstanding value may be higher from year to year. Urban habitat can be stressful and far from ideal for urban tree planting; still, we expect healthy tree growth to fulfil the maximum in all aspects of the trees' ecosystem supply from environmental regulation to social and aesthetic functions. The urban conditions and factors (reflected, radiated heat, polluted air and soil, lack of intensive maintenance, traffic burden, social overuse, restricted root volume, soil compaction, etc.) cause severe stress to urban trees' visible signs quality [25,26]. The tree stock's measurement and evaluation along Andrassy Avenue used the Hungarian Association for Tree Management's [27] method and criteria, based on European visual tree assessment methods [28,29]. The dendrological survey is the overall tree recording, where the dendrometric characteristics express the full tree height, trunk height, trunk circumference size, trunk diameter, and crown diameter in numbers. Trunk diameters come in two ways; either with the average of two diagonals' measured values or with the calculation out of the trunk circumference size. The diameter's measurement or its calculation is essential for the definition of the tree's approximate age.

The trees' general data are as follows: survey number of trees, scientific and common name; Individual data: total height, trunk height, average trunk diameter at an altitude of 1 m, average crown diameter, breast height (130 cm), and trunk diameter in specimens tested instrumentally.

All trees are unique and form a physiologically coherent whole. A detailed examination is necessary because the habitat condition is often different from ideal, which affects the whole tree's life chances. During the visual inspection, the general state of the roots, trunk, and crown are essential. We applied the EU conform method developed by MFE (association of Hungarian arborists) [30], which uses five parts and values (value aspects details in Appendix A): A–Root system including roots and collars and the type and condition of tree's plantation site; B–Trunk condition; C–Crown condition, including the crown base and the full crown (branches, branchlets, twigs, and shoots with leaves); D–Assessment of viability; E–Degree of care, maintenance.

Visual examination of the root surface and habitat (A) is the most decisive in the root system survey without excavation. The shape of the root collar and its changes and injuries refer to the whole root system; therefore, examining these elements together gives the root system value. The trunk (B) condition fundamentally determines the tree's health; in the rotting case, the static state of wood deteriorates, limiting the nutrient and water transport. To visually inspect the trunk, it is also essential to consider the root collar and crown base, as their condition also affects the trunk. The crown base and root neck are the two most sensitive parts of the tree. We evaluated the crown structure (C) together with the crown base condition, during which the primary consideration is to determine the ratio of real to ideal foliage weight. Viability (D) depends on the crown's disease, the tree's health as a whole, and the root's and trunk's condition. The degree of tree-care (E) should be given to the ideal maintenance. Individuals who have their physiological needs, have a species-specific growth vigour, and have been cared for in timely and sound quality can be considered optimally groomed trees. With all these assessments, wood care work will become more predictable in the long run. The general condition's indicator referring to the

overall tree value is a percentage derived from the above survey's values. The calculation formula:  $(A + B + C + D + E - 5)/20$ .

### 3. Results of Site Analyses and Tree Survey

The first section, or inner part, comprehends Bajcsy-Zsilinszky—Oktogon; the second, middle part, is from Oktogon to Kodály körönd; the third, outer part, extends from Kodály körönd to Heroes Squares. Within the main sections, we can differentiate subsections bordered by crossing streets and the two main squares—Oktogon and Kodály körönd—and the Heroes' Square at the City Park termination (Figure 4).



**Figure 4.** The three sections and their typical urban landscape character. (Section 1. *Celtis occidentalis*; Section 2. *Fraxinus excelsior*; Section 3. *Fraxinus excelsior* 'Westhof's Glorie'. (edited by Szilágyi, K.; source: <https://www.nomadepicureans.com/europe/hungary/free-budapest-walking-tour-self-guided/> (accessed on 27 February 2021)).

#### 3.1. Andrassy's Urban Character and Functions

Alongside the street, public and private buildings, cultural and educational institutes, and valuable monuments create the elegant urban space walls reflecting the most exemplary architecture of late classicism and eclectic style. Here is the famous Hungarian State Opera, for example. Moreover, urban design and architecture quality are equal to the 19th-century European urban development and renewal trends.

The research findings for the urban land use and functions show that Section 1 has an imposing metropolitan atmosphere, together with strong commercial and cultural values, high tourism activity and internationally famous brands' shopping stores (Figure 5a). With a significant profile change, Section 2 presents an increase in urban green character. Consisting of more residential and educational buildings and with a double tree-lined promenade on each side, this part still has a high tourism activity (Figure 5b). From Kodály körönd square to Városliget (City Park), in Section 3, the avenue reflects a more "natural" atmosphere. There, detached housing and villas' gardens resemble a significant increase of green coverage. Continuing with the doubled tree-lined promenade, many buildings here function nowadays as embassies, institutions, hotels, museums, and restaurants, maintaining the tourism activity (Figure 5c).

Regarding the allées traffic & functional connections, Andrassy can be considered an urban motorway with heavy traffic throughout. Starting at Bajcsy-Zsilinszky, the first section with a 34m width consists of the main road (2 + 2 traffic lanes) and a 1 + 1 bike lane, up to the Oktogon (Figure 5a). The 45.5 m wide second section progresses to Kodály körönd with the main road plus 1 + 1 service roads and 1 + 1 bike lane (Figure 5b). The width and traffic lane structure is similar in the third section, but the residential villas' front gardens add extra green to the urban landscape. (Figure 5c). Furthermore, there is no bus line, except for tourism buses going to and from Heroes square. Multiple stops of the metro line 1 are also present, connecting the city centre to the Városliget Park and beyond.

The degradation of Andrassy Avenue from an open and green urban linear space system into a busy urban motorway resulted in the loss of the original, glorious intention to create a large-scale link to the nature of Városliget. Especially in the third section, the



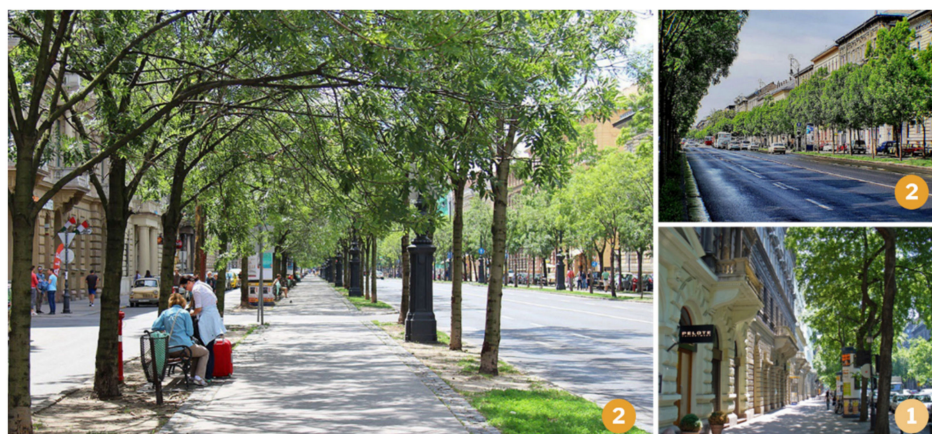
new tree plantation with the compact crown form and the unnatural trunk height serve only the heavy traffic and the tourist buses.



**Figure 5.** Urban context, functions, monuments and character; (a) Section 1; (b) Section 2; (c) Section 3. (edited by Rosa & Lahmar; sources: <https://pocketoz.com.au/suitcase/dest-budapest.html> (accessed on 27 February 2021); <https://www.budapesttips.co.uk/budapest-attractions/opera-budapest/> (accessed on 27 February 2021)).

### 3.2. Green System and Habitat Analyses along Andrassy Avenue

All along Andrassy Avenue, the urban habitat and the trees' vulnerable condition are negatively impacted by the urban context and functions (Figure 6). The dense traffic, four-five-storey high buildings (typically in Section 1) causing sizeable shaded area together with compacted and polluted soil and artificially restricted place for the root system resulted in severe damages, like heavily tilted trunks and deformed crowns. The century-old hackberry trees need regular crown shaping maintenance to improve stability.



**Figure 6.** Stressful urban habitat along Andrassy Avenue, Section 2. and 1. (edited by Rosa & Lahmar; source: <http://holpihenj.com/andrassy-ut/> (accessed on 27 February 2021)).

Due to the broader cross-section in the second part and the tree canopy's lower density, the crown conditions are slightly better than in Section 1. However, during the last maintenance procedure, the artificial grass layer disappeared, revealing the poor root state, causing trunk damages and diseases. The third section seems the best thanks to the even broader cross-section, the linear green area offering a bit healthier habitat for the trees and the protective planting design applied on both sides of the linear green space.

### 3.2.1. Urban Habitat and Planting Places

There are different tree-planting situations in the three sections, which strongly determine the life cycle and lifespan and their decorative character and health conditions (Figure 7). The examined trees were 816 in three sections and two squares among different states (Table 1). In terms of individual numbers, the data are as follows: Ten trees stand in the four green islands of Kodály körönd square; 13 trees are in Oktogon square along the pavement. The first section contains 182 trees in two rows (A-95, B-87), the second section has 274 individual trees in four lines (A-74, B-68, C-59, D-73), and the third section has 337 trees in four lines (A-92, B-81, C-77, D-87). In Sections 2 and 3, the inner rows (B and C) are significantly weaker because of the traffic disturbance and have much fewer trees than the outside lines.



**Figure 7.** Urban allée's habitat in the three sections from the strictly urban to a moderate urban green space, 2021 January. (photo: Szabó, K., 30 January 2021).

The root growth is severely limited in the first section because of small tree pits ( $1 \times 1$  m). In the case of older individuals, the roots push into the tree grates and covers. Due to the lack of space and the buildings' shading, the trunks are oblique, and the crowns asymmetrical.

In the second section, the trees grow in narrow green stripes without protection against trampling, compaction, salting, etc. The roots of medium, adult, and old trees are visible on the surface due to maintenance problems. Despite the intensive pedestrian use, the maintenance insisted on creating and keeping up green surfaces; as all plantation and greening efforts failed, artificial grass cover supplied the green surface colour without supporting, regulating green ecosystem supply. The roots started to grow upwards in the absence of sufficient oxygen. The artificial irrigation system, keeping the perennials' plantation, also motivated the root system towards surface growth. The wide pathway between the two green stripes is not water permeable. The narrow plantation line has no protection against winter salting, causing severe damage along the traffic road lanes. Salting material, dangerous for young trees' root system, has a high chlorine emission into the absorption zone. Thus, the overall environmental condition is deficient in Section 2, resulting in many trees dying out or felling.

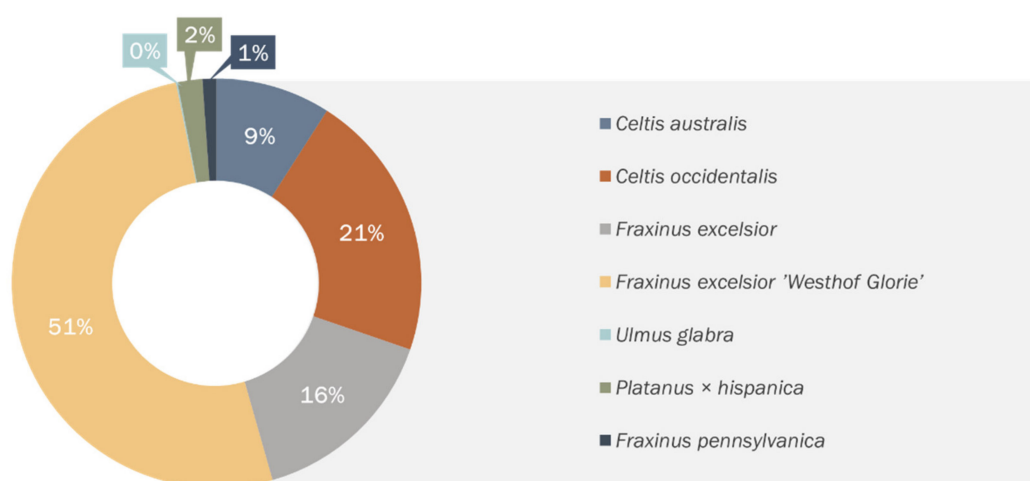
The third section's habitat seems much better than the two previous. There are broad green stripes, semipermeable cobble cover on pathways, linear shrub plantation for protection against winter salting, and less intensive use.

**Table 1.** Primary data of the Andrassy tree survey. (edited by authors).

Sections	Length (m)	Character	No. of Rows	No. of Trees	Species (Dominant in Bold)
I.	844	closed rows installation, no service road and walkway, trees in tree pits, opposite plantations	1 × 1	182	<i>Celtis australis</i> , <b><i>Celtis occidentalis</i></b>
II.	563	closed rows installation, service road and walkway, trees in the green bar, alternate plantations (triple bond)	2 × 2	274	<b><i>Fraxinus excelsior</i></b> , <i>F. ex. 'Westhof's Glorie'</i> , <i>F. pennsylvanica</i> , <i>Platanus</i> × <i>hispanica</i> , <i>Ulmus grabra</i> , <i>Celtis australis</i>
III.	656	closed rows installation, service road and walkway, trees in the green bar, alternate plantations (triple bond)	2 × 2	337	<i>F. ex. 'Westhof's Glorie'</i>
Oktogon		plantation in tree pits, along the four square borders	1 × 1	13	<i>Celtis australis</i> , <b><i>Celtis occidentalis</i></b> , <i>Platanus</i> × <i>hispanica</i>
Kodály Körönd		the plantation is in the green area on green islands	1 × 1	10	<b><i>Platanus</i> × <i>hispanica</i></b> , <i>Celtis occidentalis</i>

### 3.2.2. Species Uniformity/Diversity

Seven different taxa live nowadays in the allée owing to several reconstructions and renewals (Figure 8). There are still some old individuals, such as the sycamore trees (*Platanus* × *hispanica*) from the first plantation on Kodály körönd square, and in the second section from the replantation program after WW1. Old *Celtis* trees are still in Section 1, and one single old elm tree (*Ulmus glabra*) planted in 1949 stands in the middle area. Hackberries (*Celtis* spp.) grow in the squares too. The first and second sections show a great variety in the time dimension.

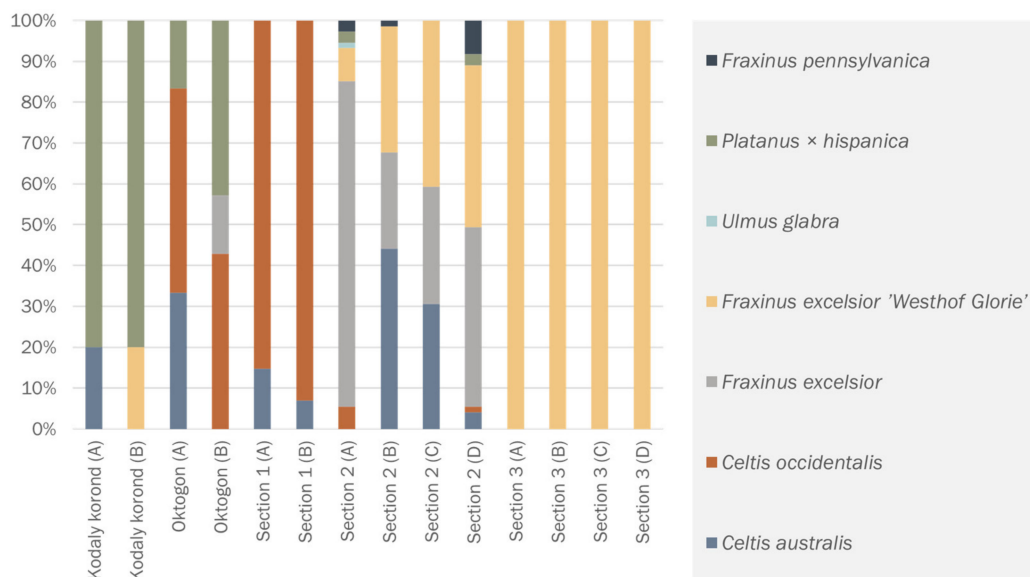


**Figure 8.** Taxa variety in Andrassy Avenue. (edited by Szabó, Rosa & Lahmar).

Due to the several replantation periods and the variable planting design, uniformity is only characteristic in the third section. The first part contains old and younger trees, where older ones are *Celtis occidentalis*, while the younger, newly replanted trees are *Celtis australis* and *C. occidentalis* mixed. The taxa confusion is more significant in the second



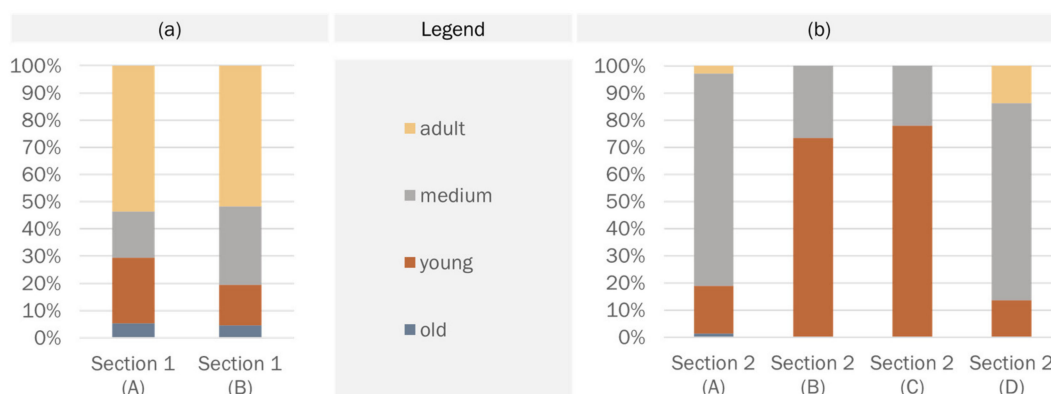
section. Some old sycamores and a single *Ulmus glabra* stand there, with several *Fraxinus* taxa. The last year's replantation resulted in a new taxon, the *Celtis australis* appearing in the first and middle sections (Figure 9).



**Figure 9.** Tree taxa in the linear sections and the two main squares. (edited by Szabó, Rosa & Lahmar).

### 3.2.3. Age Uniformity

The oldest trees live in the Kodály körönd square, while the youngest individuals stand in the second section. The age difference between the oldest and the most immature trees is around 150 years. In many cases, the difference is about 70–80 years. Many trees had to be replanted in the past decade owing to severe environmental load and plant protection problems. The proportion of young or freshly planted trees is high in Section 2, line B and C (Figure 10a,b).



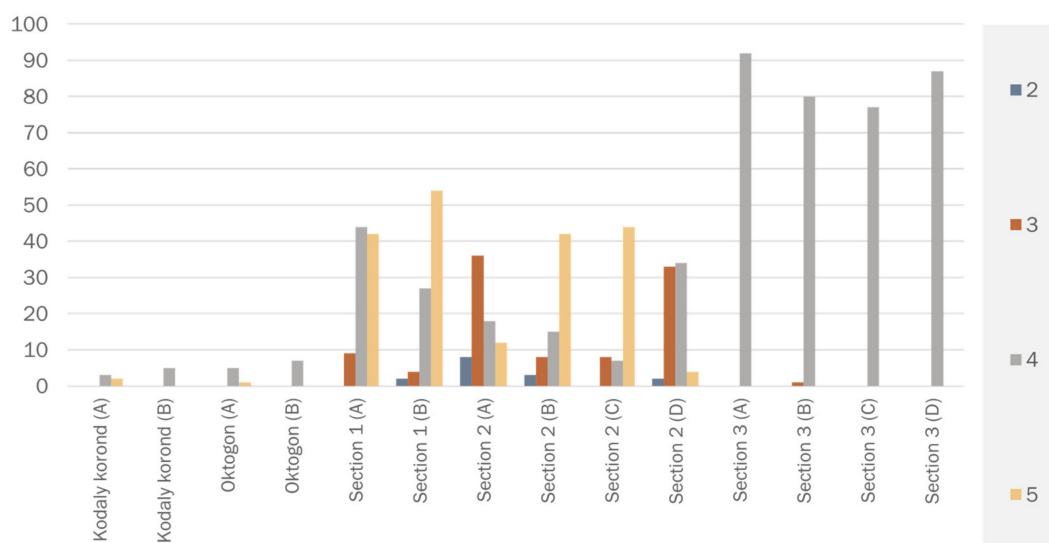
**Figure 10.** Tree's age variety; (a) Section 1; (b) Section 2. (edited by Szabó, Rosa & Lahmar).

### 3.2.4. Condition of Roots, Root Collars and Tree Pits

Based on Rado's value (see Appendix A), the relationships of roots, root collars and planting circumstances are different among places and sections. Individuals who did not show any abnormal symptoms (ground cracks, root congestion, girdling roots, damaged roots, bark, phloem, xylem injury, fungal infection, etc.) received excellent values. The highest value (5) is characteristic in the second section due to the many new replanted



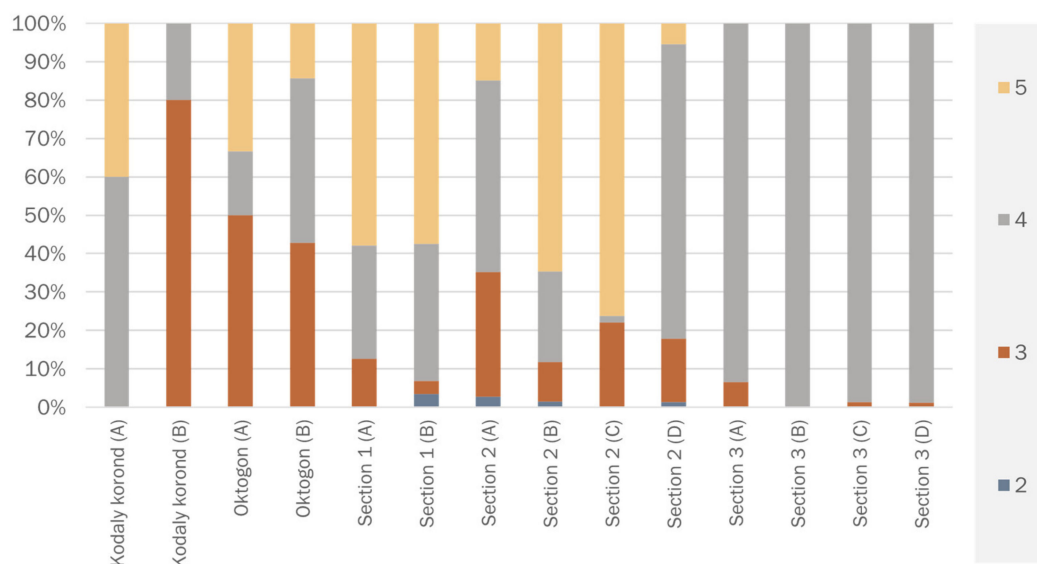
trees; good and medium values are typical in the first section thanks to healthy rooted individuals (Figure 11).



**Figure 11.** State of the root system in the studied area. (edited by Szabó, Rosa & Lahmar).

### 3.2.5. Trunks' Condition

The trunk condition shows relatively high values. Severe wounds, damages, and serious injuries are infrequent (Figure 12). Values B in Appendix A.

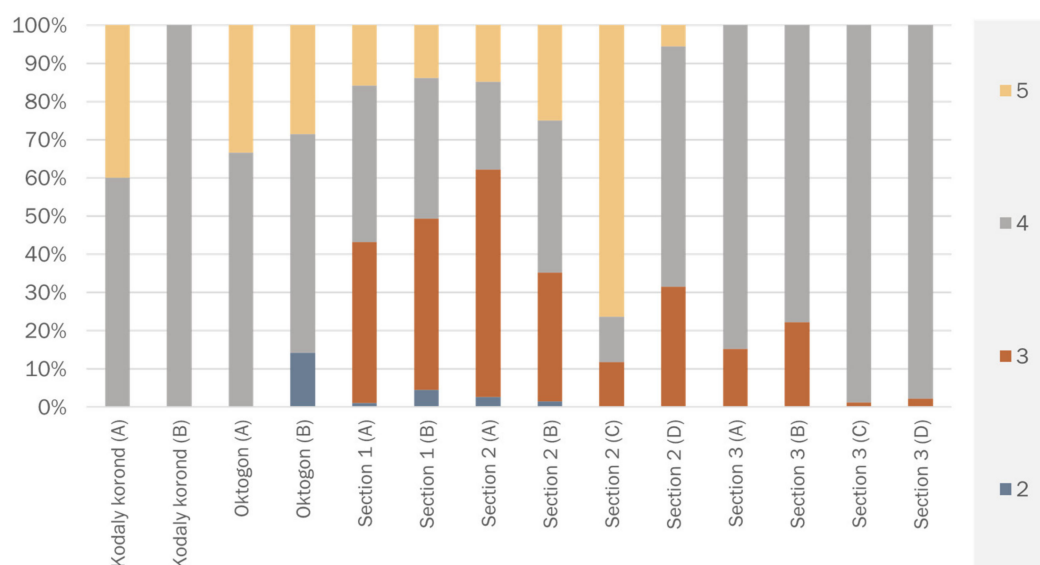


**Figure 12.** Correlations of the trunk values in the studied sections. (edited by Szabó & Rosa & Lahmar).

### 3.2.6. Crowns' Condition

The crown shape and size depends on location and retention condition. If root development is limited, water absorption and the nutrient transition is also limited, and the crown shows a less decorative value than the ideal. A value of 5 is scarce, almost only in the case of a new plantation as in the inner row C in Section 2 (see in Figure 13). Value 2 occurs in some individuals with foliage loss of more than 50% and severe crown damages. Value 4 reflects a good tree stand with a foliage loss of 11%–25%. We found many weak

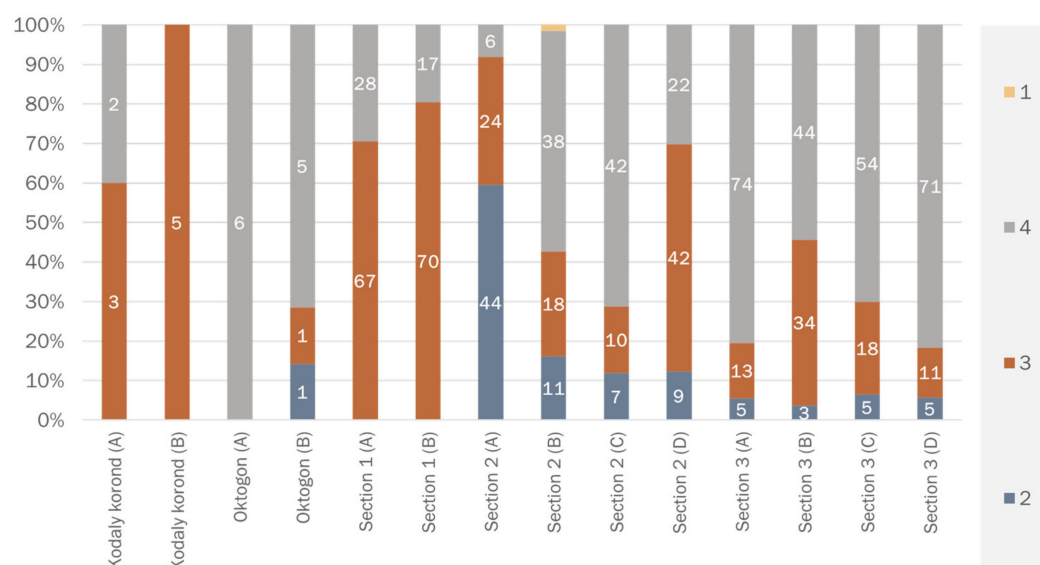
crowns in (values 3 and 2) Section 2 during the survey, where replantation is necessary within five years.



**Figure 13.** Correlations of crown values in the studied sections (value C in Appendix A). (edited by Szabó, Rosa & Lahmar).

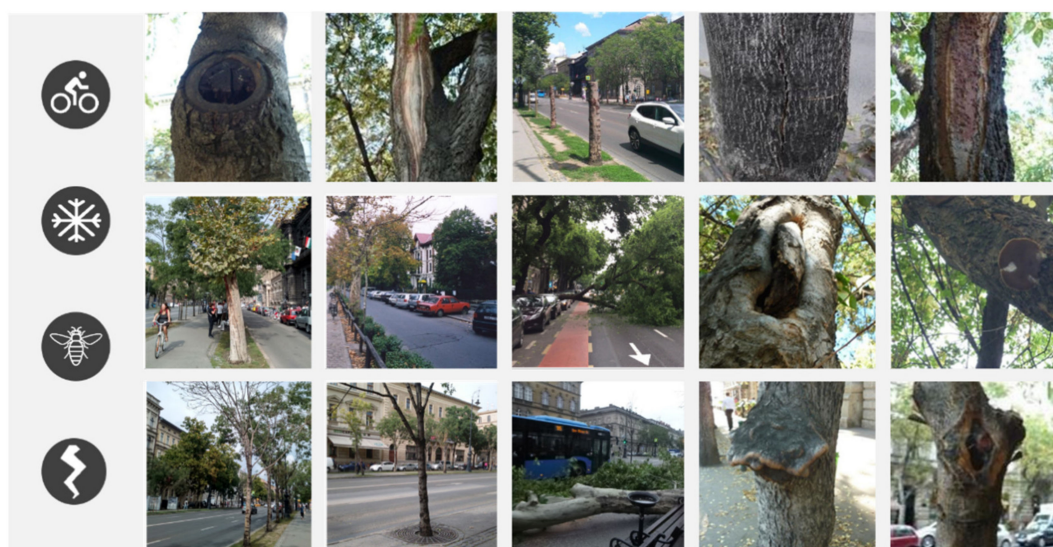
### 3.2.7. Correlation of Vitality

The vitality is a complex value, and it is difficult to determine, as assumptions are needed regarding future habitat conditions. Trees planted in congested urban environments, especially when planted in a tree pit, cannot survive without proper maintenance. Thus, only in exceptionally optimal cases did the individuals receive a rating of 5 (excellent) for their vitality; otherwise, trees with good values received only 4 (it can reach maximum age by intervening). At the time of our study, only one individual needed urgent removal (values 1) (Figure 14).



**Figure 14.** Correlations of vitality values in the studied sections (value D in Appendix A). (edited by Szabó, Rosa & Lahmar).

The professional maintenance experienced a 15-year decrease in life expectancy due to the polluted and disturbed urban environment. This is the second section's very situation so far (Figure 15).



**Figure 15.** Trees' damages, diseases and accidental falls. (edited by Szilágyi, Rosa & Lahmar; photo: Szilágyi, Szabó, Rosa, Lahmar, Szaller, 2010, and online source: <https://www.fokert.hu/andrassyut/> (accessed on 15 October 2020).

#### 4. Discussion

As a summary of the survey, the first statement made concerns the weak condition of the urban allée's trees due to the unfavourable habitat offered in the linear open space. The main problem is the continually deteriorating condition of the urban environment with pollution and overall environmental burden caused by the urban motorway, the intensive traffic generating an unhealthy urban microclimate, a severe heat island effect, air and soil pollution, lack of natural soil system, contamination, and physical damages due to all sorts of traffic. The lack of green surface and the restricted root system in Section 1 resulted in a weak tree condition and many old trees dying out. The direct car traffic's disturbance is responsible for both inner tree rows' inadequate status in Sections 2 and 3.

Trunk and crown deformation is an aesthetical problem, and the visual aspect is a critical element of the urban landscape. Due to the buildings' proximity, some older individuals bend towards the street or the sidewalk, posing a hazard to both properties (cars, bicycles, motorcycles, etc.) and passers-by. Diseases and fungal infections cause tree dying and increase the risk of branch or trunk rupture. The damaged and exposed root system, spreading and breaking the pathways, adds to the risk to pedestrians and ruins the paving materials and urban infrastructure.

After several reconstructions and renewals, we found seven taxa in the allée's rows that means a great variety according to the original urban landscape plan. The initial planting design offered the sycamore trees for the entire length of Andrassy Avenue. The choice had a strategic and aesthetical meaning and counted with the ecological needs of this taxon. The green link between the city and the nature of Városliget was a potent symbol in the 19th century's avenue program. However, another emblem appeared in the planting design. Palatine Joseph presented sycamore trees in large quantity from his tree nursery in Alcsút for the plantation of the new urban park, Városliget.

As for the ecological needs, the habitat seemed convenient for these trees as *Platanus* taxa need a direct connection to underground water sources. Since then, the urban development's growing intensity, construction of Metro 1, public works and tubes, and several underground garages in the close neighbourhood have lowered groundwater level [27]. Among other factors, the lack of groundwater supply played a determining role in the sycamores' unhealthy state. Nowadays, *Platanus × hispanica* represents only 2% in the whole area. However, we cannot deny that the cross-sectional features in the first section were not exactly conducive to the healthy development of *Platanus* trees.

The planted tree species are very different along Andrassy Avenue except for Section 3 (Figure 16). Still, there is no relationship among the number of individuals, tree species and various areas. The tree diversity is due to previous plantations' abandoned specimens, the extent and replacement of dead trees owing to environmental burden and conditions, and different professional considerations. Section 1 has a characteristic, mature *Celtis occidentalis* allée with more and more dying trees. Still, thanks to intensive maintenance, tree pits do not remain empty for a long time. In Section 1 and even in Section 2 with a new taxon, *Celtis australis*, the replantation went on here, hoping to maintain a healthy allée for a longer time. Section 2 seems the most confused and mixed in the number of taxa (six different taxa in two rows), the age and the quality context. Section 3 is homogenous according to the taxon and the age resulting from the last renewal program, but the condition is not so much promising. *Fraxinus excelsior* 'Westhof's Glorie' was considered urban tolerant in the early 2000s. Since then, the plantation's state has questioned this professional statement.



**Figure 16.** Tree's taxa variety (percentage and number of individuals); (a) Section 1; (b) Section 2; (c) Oktogon; (d) Kodály Körönd. (edited by Szabó, Rosa & Lahmar).

Section 1 has a characteristic, mature *Celtis occidentalis* allée with more and more dying trees; thanks to the intensive maintenance, tree pits do not remain empty for a long time. In Section 1 and even in Section 2 with a new taxon, *Celtis australis*, the replantation went on here, hoping to maintain a healthy allée for a longer time. Section 2 seems the most confused and mixed in the number of taxa (six different taxa in two rows), the age and the quality context.



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The Andrassy Avenue tree survey confirmed the destructive effects of the urban environmental pressures on the trees’ condition. Despite all maintenance efforts and even the recently replantation action, the allées and the green space obviously suffer in the given urban ecosystem. It is important to plan more feasible and efficient urban allée reconstruction strategies where successful precedent cases or current proposals may offer a new solution more effectively and sustainably. It would be possible to apply similar techniques, and approaches to the Andrassy Avenue case by precedent analyses. An excellent example of urban allée renewal is the ever-so-famous Paris avenue, the Champs Elysée.

The Paris Champs Elysée, the once model for the glorious urban avenue development in the 19th century, offers the new idea and model for a sustainable and livable urban renewal again. Three centuries after its official opening, the Paris’ Champs Elysée avenue is still an outset of western modernity, inspiring several similar projects worldwide. The revolutionary design approach has changed the city’s urban tissue and has created the impression of a city built with the prospect of infinite progress. Moreover, the unique charm and the symbolic dimensions make the Champs Elysée a site of national celebrations and major popular events, in addition to economic development and globalisation. However, since 1970 the avenue has lost its genuine aim and purpose, being a green open avenue for promenades and major festivities resulting from its significant economic, social, touristic, and political evolutions. The excesses of global over-tourism and intense automotive usage are negatively impacting the avenue’s reputation and condition.

Throughout its history, the avenue had several renewal projects. In 1992, a renewal project launched by Paris city aimed to widen and raise the granite sidewalks, maintain the double rows of plane trees, place advertisement columns with telephones and tropical wood benches to improve the pedestrian experience. However, due to the intensity and type of use, renewal projects are necessary from time to time. The new project launched and communicated first in January 2021 by the official authorities’ aims to transform the avenue into an urban demonstrator of sustainability and inclusivity.

The action plan has four aspects: 1. To reduce mobility nuisances by liberating more open space for pedestrians, and the installation of a silent pavement on the vehicular road by 2030, resulting in a drastic reduction in noise pollution; 2. Inventing new use forms by coordinating cultural and scientific events in parks, gardens, and green open spaces; 3. Installing free educational equipment for the younger generations while protecting and respecting the heritage and character of the avenue; 4. The project aims to rethink the ecosystem of the Champs Elysée by designing permeable pavement on the sidewalks, allowing water infiltration into retention basins, release the trees from their geometric shapes in favour of a free crown and root system expansion, increase the vegetation on the shrub level, and enrich the plantation in the gardens to increase the shaded areas and improve the evaporation for the benefit of biodiversity. Lastly, the project aims to collect data by installing sensors all along the avenue to monitor transportation flows, supply and evacuation of rainwater, benefit the economy, and environmental comfort in the urban ecosystem [31].

Unfortunately, Andrassy Avenue’s green infrastructure’s visual–aesthetical values are severely questioned due to the trees’ health condition and the mixed, non-uniform appearance both in taxon and age contexts. The mixture of young, aged, mature, or old trees proves the constant efforts to maintain the allée on the one hand, but it may still disturb the overall character for an extended period. The taxon diversity is also an essential question, especially for a possible renewal program.

In climate change and global and urban warming, biodiversity in green infrastructure may be vital for ecosystem provision and stability. In Alnarp, Sweden, in 2014, the First

International Conference on Urban Tree Diversity offered a good understanding of the urban tree diversity issue [32]. The conference paper stressed the importance of tree diversity from socioeconomic status and cultural aspects too. Even the great variety of urban land use forms offers possibilities for the enlargement of assortment. “Urban ecosystem represents the most complex vegetative land cover, and multiple land uses of any landscape.” [33]. As for taxon diversity in allées, the Morgenroth paper [32] notes that “species diversity may also be necessary for urban ecosystem stability”, still “... increasing tree species diversity does not guarantee improved ecosystem function.” For visual effects, still, the allée of only a single even-aged species may offer a designed urban character, even if the allée is a historical one. On the other hand, there are more possibilities to arrive at a higher tree diversity even in urban allées. “Santa Monica, USA, developed its urban tree diversity by planting single-species along individual streets, thus achieving diversity at the city-level, while also strengthening local distinctiveness [32].

On the contrary, MacDonagh’s planting design idea is determined in the ecological and aesthetic values of tree diversity when asks: “let’s have allées, avenues, boulevards, and groves of richly diverse tree species in our cities that are complementary in shape, form and colour.” [34].

In Andrásy Avenue, moderate tree taxon diversity is a necessity because of the cross-sections variety. In the first section, we have to admit that due to the built-in urban system and the subsequent installation of metro 1, the sycamore trees did not have much chance of maintaining a healthy, beautiful crown. On the other hand, the two broad sections, Sections 2 and 3, may require different taxa to fit the large-scaled view. The third section would be possible to find a way for the promenade’s authentic reconstruction that fits into the urban landscape and attracts city dwellers and tourists again. Beautifully renovated city villas on both sides, the appearance of new features offering a tourist program also reinforces the idea of an authentic renovation.

As proven in our allée and tree survey, the inner rows along the busy traffic lanes in Sections 2 and 3 are, for the most part, in worthy condition owing to the direct environmental burden. If the present traffic system and intensity remain, the inner rows might have new, more tolerant taxon, as the chief landscape architect of Budapest Municipality envisions. We doubt the visual, aesthetic value of such diversity in the case of Andrásy Avenue. Our age’s sustainability and liveability concepts need contemporary technical and urban planning solutions for urban ecological improvement and the decrement of urban traffic in inner-city areas.

## 5. Conclusions

Looking back into Andrásy avenue’s one and a half-century-long history, we can observe all renewal and development projects used to support the urban traffic intensification. However, the allée’s maintenance and renewal from time to time tried to keep pace with the environmental quality problems posed by the avenue, which had gone from a former promenade to a central urban road. Due to the severely damaged and polluted habitat along Andrásy Avenue, the trees stand cannot compete with the urban environment’s disadvantages. Finally, in the 21st century, parallel with the green and friendly city idea and the liveability criteria, harmony and balance would be essential among the urban functions [35]. The listed World Heritage site cannot be an urban motorway anymore. The once glorious urban open space and its architecture and living heritage have more essential values and public life’s opportunities for both the residents and tourist than driving, biking or walking along the running, hectic urban traffic lines. The only possible way to work out the renewal concept for the avenue might be resolving road traffic, reducing traffic lanes, breaking speeds, and prioritising pedestrian and other environmentally friendly transport. Time had arrived when such a brave decision should come. Here is Paris’s bold, contemporary, and public-friendly plan as a possible example of city development and heritage protection.

However, even if the urban habitat's quality improves, the allée renewal requires a careful search for suitable tree species. Pests and pathogens that appear year after year, crossing countries very quickly, can cause a rapid collapse in plants. *Fraxinus excelsior* species seemed to be the best tolerant species 30 years ago, and today these individuals standing in urban allées die out slowly. Could we take it for sure that the new plantation with *Celtis australis*, which looks excellent today, will not have the same fate in a decade or two?

Relying on the historical values, the appearance of the allée should be uniform, but we are aware of the new, contemporary planting design principles. Monoculture is always in great danger in urban planting, mainly because of pests' more comfortable spread. For all these reasons, an utterly uniform installation of more than 800 tree individuals is not necessarily recommended. It is worthwhile to improve the diversity, first of all by section-specific taxa, secondly by preserving some old witness trees, and depending on the new open space structure and use intensity, probably among the inner and outside rows.

The present Budapest Municipality, helped by a chief landscape architect, is committed to developing the city along with sustainable, liveable, and green principles and guidelines. Among others, the restriction of car traffic, the comprehensive urban trees' and allées' renewal program and the urban tree planting's technical solutions as the Stockholm method, the soil cells are at the forefront of urban landscape architecture development. For Andrassy Avenue renewal, the municipality will launch an open competition for a complex renewal where urban habitat improvement should be vital.

The present replacement works in the allées should be only temporary management until the long-term developments begin. Based on the successful implementation, two ways are possible at significantly different costs: forming the structural soil and the suspended pavement method. Both methods support the optimal urban precipitation management and the appropriate development in the subsurface media layer, enable the proper aeration, and thus the plants' healthy root development. The primary habitat improvements cover reducing urban traffic to give space for widening and demarcating spacious green lanes, reducing trampling and compaction. For the new plantation, it is essential to add biological formulations to help adaptation and healthy growing. Moreover, similarly to the German historic garden conservation technologies applied in a changing climate environment, urban climate and ecosystem data of exceptional urban living heritage would need permanent or at least regular digital control via sensor technologies of the tree stock, the soil system and the urban temperature distribution. [36]

Sustainability and liveability concepts mentioned for Andrassy Avenue's improvement and allée renewal played a determining role in the three years-long research and planning process to work out the new green vision for the capital. In 2019, the Budapest Capital Municipality accepted the Budapest Green System's Scientific Survey and Development Concept, in 2021, the Budapest Green Infrastructure Development and Management Plan (the so-called Dezső Radó Plan) [37].

The capital is committed to the value-preserving development of urban green infrastructure and modern construction technologies and maintenance methods. However, the capital's room for manoeuvre is limited in priority zones such as the World Heritage Site and its buffer zone, such as the City Park. These developments have been routinely brought under the authority of the government, and negotiations are tough. It is also a problem that there is still the lack of a management plan to preserve the whole cityscape, which would include strict rules on the impact assessment of projects in World Heritage sites.

We, dedicated landscape architects, are confident that urban communities and society will act more and more decisively for green spaces that improve urban life quality. If nothing else, but the covid epidemic has shown how vital everyday open space recreation is.

Civil societies certainly raise awareness of the importance of living heritage, green areas and liveable, residential, and environment-friendly open spaces. The most relevant socio-ecological surveys in open space use concluded that Budapest's residents love green

places and enjoy nature. The renewed Andrásy Avenue is also likely to win lovers of urban open spaces while looking for community programs in pedestrian zones (Figure 17).



**Figure 17.** Functions, regular and occasional public use in Andrásy Avenue. (sources: [https://timelord.blog.hu/2011/09/15/az\\_andrassy\\_ut\\_az\\_autosvilag\\_elott](https://timelord.blog.hu/2011/09/15/az_andrassy_ut_az_autosvilag_elott) (accessed on 18 October 2020); <https://antikterkep.hu/budapest-andrassy-ut-opera-fenykep-1900> (accessed on 18 October 2020)).

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## Appendix A

EU conform method developed by MFE:

### Values A

5: "visibly developed root system, optimal place of production, intact root collar";

4: "root development slightly inhibited, place of production acceptable, root neck not damaged";



- 3: “minor wound rot on the roots/small defective site”;
- 2: “strong surface damage, significantly unfavourable place of production”;
- 1: “at least 50% damage to roots, poor place of production”;
- 0: “dead root system, empty tree place”

**Values B**

- 5: “intact”;
- 4: “small damage (some superficial wounds)”;
- 3: “clear damage (surface wound, rot sites)”;
- 2: “severe damage (more multiple large wounds, deep pitting)”;
- 1: “advanced damage, dead rotten strain (statically weakened, does not replenish nutrients)”;
- 0: “empty tree place”

**Values C**

- 5: “intact, max. 10% foliage loss”;
- 4: “foliage loss 11–25%”;
- 3: “significant foliage loss 26–50%”;
- 2: “severe crown damage, more than 50%”;
- 1: “dead crown, total foliage loss”;
- 0: “empty tree place”

**Values D**

- 5: “excellent”;
- 4: “it can reach maximum age by intervening”;
- 3: “to be replaced before maximum age”;
- 2: “to be replaced in 10 years”;
- 1: “to be replaced urgently”;
- 0: “empty tree place”

**Values E**

- 5: “optimal”;
- 4: “small deficit”;
- 3: “medium deficit”;
- 2: “significant deficit”;
- 1: “neglected”;
- 0: “empty tree place”

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